REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have amended each of claims 1 and 2 to recite that the layered interconnection structure includes the copper film and a neighboring film located adjacent to the copper film, this neighboring film being further defined. Claim 5 has been amended to recite that the layered interconnection structure includes the platinum film and a neighboring film, adjacent the platinum film, located at at least one of (a) above the platinum film and (b) between the platinum film and the semiconductor substrate, the neighboring film being further defined. Claims 13 and 14 have each been amended to recite a neighboring film and a diffusion barrier film located between the copper film and the insulating film, the diffusion barrier film being further than the neighboring film from the copper film, and the diffusion barrier film including at least one material selected from the group consisting of titanium nitride, tungsten and tantalum.

Initially, Applicants respectfully request that the present amendments be entered. Noting, for example, comments by the Examiner in the last paragraph of Item 7, on page 5 of the Office Action mailed February 11, 2003, it is respectfully submitted that amendments to claims 13 and 14 clearly materially limit any issues remaining in connection with the above-identified application. Noting, for example, original claims 2, 4 and 6, it is respectfully submitted that these amendments to claim 13 and 14 clearly do not raise any new issues, including any issue of new matter. Moreover, noting present amendments to claims 1, 3 and 5, it is respectfully submitted that these amendments materially limit any issues remaining in connection with the above-identified application; and, as will be discussed infra, these amendments to claims 1, 3

and 5 present claims 1-6 in allowable condition. Furthermore, noting the initial rejection of claims 13 and 14 on prior art, and also noting the additional arguments by the Examiner in connection with rejection of claims 1-6 under the second paragraph of 35 USC §112, set forth in the Office Action mailed February 11, 2003, it is respectfully submitted that the present amendments are clearly timely.

In view of the foregoing, it is respectfully submitted that Applicants have made the necessary showing under 37 CFR § 1.116(c); and that, accordingly, entry of the present amendments is clearly proper.

Applicants respectfully traverse the rejection of claims 1-6 under the second paragraph of 35 USC §112, as being indefinite, particularly insofar as this rejection is applicable to the claims as presently amended. In this regard, the Examiner contends that claims 1, 3 and 5 as previously considered "do not particularly point out that the neighboring film is adjacent to (or in contact with) the copper film (in claim 1) or the platinum film (in claims 3, 5)". The Examiner further contends in Item 7 on page 5 of the Office Action mailed February 11, 2003, that the claims as considered in the Office Action mailed February 11, 2003 "do particularly point out that the neighboring film is adjacent the copper film (claim 1) or the platinum film (claims 3, 5) for (a), but not for the alternative (b)".

Claims 1 and 3 as presently amended do not include alternatives (a) and (b), but recite that the layered interconnection structure includes the copper (platinum) film and a neighboring film located adjacent to the copper film (platinum). Thus, claims 1 and 3 respectively recite adjacency of the neighboring film to the copper or platinum film, and thus overcome the basis for rejection under the second paragraph of 35 USC § 112.

Claim 5 retains the language of at least one of (a) and (b), but claim 5 has been amended to recite that the neighboring film, "adjacent the platinum film", is located at at least one of the locations (a) and (b). Thus, it is respectfully submitted that claim 5 as now amended provides adjacency to the platinum film, when located at either of (a) and/or (b). Accordingly, it is respectfully submitted that the rejection of claims 1-6 under the second paragraph of 35 USC § 112 is moot.

Applicants respectfully submit that all of the claims now presented for consideration by the Examiner, including claims 13 and 14, patentably distinguish over the teachings of the references applied by the Examiner in rejecting claims 13 and 14 on prior art in the Office Action mailed February 11, 2003, that is, the teachings of U.S. Patent No. 6,020,266 to Hussein, et al., and the article entitled "Diffusion Barrier between Copper and Silicon" in IBM Technical Disclosure Bulletin, vol. 35, No. 1B (June 1992), pages 214-215, under the provisions of 35 USC § 103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a semiconductor device having a layered interconnection structure as in the present claims, including wherein the layered interconnection structure overlies an insulating film and includes (1) a copper film, and (2) a neighboring film and (3) a diffusion barrier film located between the copper film and the insulating film, the diffusion barrier film being further than the neighboring film from the copper film, the neighboring film having as a primary constituent element thereof, an element selected from the group consisting of rhodium, ruthenium, iridium, osmium and platinum, and the diffusion barrier film including at least one material selected from the group consisting of titanium nitride, tungsten and tantalum. Note claims 13 and 14.

Through use of the neighboring film, a diffusion of copper can be avoided. Moreover, through use of the barrier film such as titanium nitride, tungsten and tantalum, adhesiveness to the insulating film can be improved. Note, for example, the paragraph bridging pages 25-27 of Applicants' specification.

Hussein, et al. discloses fabrication of via plugs and metal lines in interconnect systems. The structure includes a barrier layer 5 (note Fig. 1) which prevents a metal line 11, that is layer-deposited in each via 4 within dielectric layer 3, from diffusing into the underlying and adjacent dielectric layer 3. Note column 3, lines 1-11. This patent discloses that appropriate conductive materials for the barrier layer 5 may be titanium nitride or tantalum. See column 3, lines 18 and 19. This patent further discloses a thin conductive layer 7 deposited over barrier layer 5, this conductive layer 7 providing enhanced adhesion of the via plugs 32 and metal lines 30 to the substrate. This patent discloses that it is preferred that conductive layer 7 includes the same metal, or a metal with a same crystalline orientation, as the metal to be deposited into the via 4; for example, if copper is to be used as an interconnect metal for substrate 1, it is preferred that conductive layer 7 includes copper or a metal with a same crystalline orientation such as nickel. Note column 3, lines 46-55.

It is respectfully submitted that Hussein, et al. discloses a diffusion barrier such as titanium nitride and tantalum adjacent the dielectric layer 3, with a conductive layer 7 thereon. It is respectfully submitted that this disclosure in Hussein would have neither taught nor would have suggested the neighboring film and diffusion barrier film, of materials as recited in claims 13 and 14, with the diffusion barrier film being further than the neighboring film from the copper film.

It is respectfully submitted that the additional teachings of the article from the IBM Technical Disclosure Bulletin would not have rectified the deficiencies of Hussein, et al., such that the presently claimed invention would have been obvious to one of ordinary skill in the art. Thus, the article discloses a diffusion barrier between copper and silicon. This article discloses that the problem to be solved is to find a diffusion barrier between copper and silicon (a) which does not interact with silicon, and (b) into which copper does not diffuse up until at least 500 °C. This article discloses that the metal that ideally fulfills these criteria is rhenium; and that similar desirable values of the elastic constants and eutectic temperatures are a property of osmium, ruthenium and iridium as well.

Initially, it is emphasized that the article from the IBM Technical Disclosure Bulletin is concerned with a diffusion barrier between copper and silicon, (that is, not silicon oxide, a dielectric material). It is respectfully submitted that one of ordinary skill in the art concerned with in Hussein, et al., looking to diffusion barriers adjacent a dielectric layer such as silicon oxide, would not have looked to the applied article disclosing a diffusion barrier between copper and silicon (that is, a barrier which does not interact with silicon). In this regard, note that the article discloses that a material which does not interact with silicon "can be fulfilled by choosing a metal which does not form a silicide with silicon up to at least 1200°C". Such disclosure is not relevant in connection with a metal adjacent silicon oxide. In view of different properties and reactivity of silicon and silicon oxide, and again emphasizing that the applied article is concerned with a diffusion barrier between copper and silicon, one of ordinary skill in the art concerned with in Hussein, et al. would not have looked to the teachings of the applied article.

In any event, even assuming, arguendo, that the teachings of Hussein, et al. and the applied article were properly combinable, it is emphasized that the Examiner contends that it would have been obvious to substitute ruthenium from the applied article as the diffusion barrier material of Hussein, et al. Thus, even assuming, arguendo, that the teachings of the applied references were combined as alleged by the Examiner, such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter as in claims 13 and 14, having the neighboring film and the diffusion barrier film, much less wherein the diffusion barrier film is further than the neighboring film from the copper film, and advantages thereof as discussed in the foregoing.

The contention by the Examiner in the first paragraph on page 4 of the Office Action mailed February 11, 2003, that the article from the IBM Technical Disclosure Bulletin "does teach that ruthenium (as well as rhenium, osmium and iridium) is an exceptional barrier against the diffusion of copper (see first sentence of final paragraph)" is noted. It is respectfully submitted that this statement by the Examiner is too broad an interpretation of the teachings of this article. To the contrary, it is respectfully submitted that this article only teaches, at most, the use of various materials as a diffusion barrier between copper and silicon. For example, neither the applied article, nor Hussein, et al., indicate what effect, for example, ruthenium would have in contact with silicon oxide, for example, adhesiveness to silicon oxide or diffusivity into silicon oxide. Absent the description in Applicants' specification, which of course is not available under 35 USC §103, there would have been no disclosure from the teachings of the applied references, as to any effect between, for example, ruthenium and silicon oxide. Thus, contrary to the allegation by the Examiner, it is respectfully submitted that

the teachings of the applied references would have neither taught nor would have suggested the presently claimed subject matter, including the neighboring film between the copper film and the insulating film, much less where the structure additionally includes a diffusion barrier film further than the neighboring film from the copper film.

In view of the foregoing comments and amendments, entry of the present amendments, and reconsideration and allowance of all claims remaining in the application, are respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current Amendment After Final Rejection. The changes are shown on the Attachment captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

To the extent necessary, Applicants petition for an extension of time under 37 CFR § 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135 (Case No. 501.36931CX1) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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"VERSION WITH MARKINGS TO SHOW CHANGES MADE"

1. (Twice Amended) A semiconductor device having a layered interconnection structure including a copper film overlying a surface of a semiconductor substrate, wherein the layered interconnection structure includes the copper film and a neighboring film located [at at least one of (a)] adjacent to the copper film [and (b) between the copper film and the semiconductor substrate], the neighboring film having, as a primary constituent element thereof, an element selected from a group consisting of rhodium, ruthenium, iridium, osmium and platinum, wherein the neighboring film substantially prevents voids due to electromigration of copper.

3. (Twice Amended) A semiconductor device having a layered interconnection structure including a platinum film overlying a surface of a semiconductor substrate, wherein the layered interconnection structure includes the platinum film and a neighboring film located [at at least one of (a)] adjacent to the platinum film [and (b) between the platinum film and the semiconductor substrate], the neighboring film having, as a primary constituent element thereof, an element selected from a group consisting of rhodium, ruthenium, iridium and osmium, wherein the neighboring film substantially prevents voids due to electromigration of the platinum.

5. (Twice Amended) A semiconductor device having a layered interconnection structure including a platinum film overlying a surface of a semiconductor substrate, wherein the layered interconnection structure includes the platinum film and a neighboring film, adjacent the platinum film, located at at least one of (a) [adjacent] above the platinum film and (b) between the platinum film and the semiconductor

substrate, the neighboring film including an element selected from a group consisting of rhodium, ruthenium, iridium and osmium, wherein the neighboring film substantially prevents voids due to electromigration of the platinum.

13. (Amended) A semiconductor device having a layered interconnection structure comprising:

a semiconductor substrate;

an insulating film overlying a surface of the semiconductor substrate; and

a plug of conductor film electrically connecting the semiconductor substrate with the layered interconnection structure,

wherein the layered interconnection structure overlies the insulating film, and includes (1) a copper film, and (2) a neighboring film and (3) a diffusion barrier film located between the copper film and the insulating film, the diffusion barrier film being further than the neighboring film from the copper film, the neighboring film having as a primary constituent element thereof, an element selected from a group consisting of rhodium, ruthenium, iridium, osmium and platinum, and the diffusion barrier film including at least one material selected from the group consisting of titanium nitride, tungsten and tantalum.

14. (Amended) A semiconductor device having a layered interconnection structure comprising:

a semiconductor substrate; and

an insulating film overlying a surface of the semiconductor substrate,

wherein the layered interconnection structure overlies the insulating film, and includes (1) a copper film, and a (2) neighboring film and (3) a diffusion barrier film located between the copper film and the insulating film, the diffusion barrier film being further than the neighboring film from the copper film, the neighboring film having as a primary constituent element thereof, an element selected from a group consisting of rhodium, ruthenium, iridium, osmium and platinum, and the diffusion barrier film including at least one material selected from the group consisting of titanium nitride, tungsten and tantalum.